



# Halocarbons: Ozone Depletion and Global Warming Overview

Halocarbons are chemical compounds containing carbon, one or more halogens, and sometimes hydrogen. Some halocarbons (“ozone depleting substances,” or ODSs) deplete the ozone layer, while others (“greenhouse gases,” or GHGs) are thought to contribute to global warming. Many halocarbons are considered to belong to both categories.

## Ozone Depleting Substances

Stratospheric ozone is constantly being created and destroyed through natural cycles. Various ODSs, however, accelerate the destruction processes, resulting in lower-than-normal ozone levels. The ozone depletion potential (ODP) is the ratio of the impact on ozone of a chemical compared to the impact of a similar mass of chlorofluorocarbon (CFC) 11.

Class I ODSs typically have an ODP of greater than 0.1 and include CFCs, halons, carbon tetrachloride, methyl chloroform, methyl bromide, hydrobromofluorocarbons (HBFCs), and chlorobromomethane. Class II ODSs are hydrochlorofluorocarbons (HCFCs). They deplete stratospheric ozone, but to a lesser extent than most Class I ODSs. HCFCs generally have ODPs of 0.1 or less. Selected timeline elements for ODS phase-out are shown in Exhibit 1.

EXHIBIT 1  
ODS Phase-out Timeline

United States			Montreal Protocol	
Date	No Production or Importation of:	ODS Class	Date	US HCFC Consumption Allowed ODP-weighted Metric Tons (OMT)
1/1/1994	Halons	I		
1/1/1996	CFCs, carbon tetrachloride, methyl chloroform, HBFCs (some exceptions)	I		
1/1/2003	HCFC 141b (some exceptions)	II		
8/18/2003	Chlorobromomethane (CBM)	I		
			2004	9,906 OMT (65% of Cap)
1/1/2005	Methyl bromide (some exceptions)	I		
1/1/2010	HCFC 142b, HCFC 22 (except for use in equipment manufactured before 1/1/2010)	II	2010	5,334 OMT (35% of Cap)
1/1/2015	All HCFCs (except for use as refrigerants in equipment manufactured before 1/1/2020)	II	2015	1,524 OMT (10% of Cap)
1/1/2020	HCFC 142b, HCFC 22 (no exceptions)	II	2020	76.2 OMT (0.5% of Cap) HCFCs may be used for maintenance purposes only
1/1/2030	All HCFCs (no exceptions)	II	2030	0 OMT (0% of Cap)

## Greenhouse Gases

The global warming potential (GWP) represents how much a given mass of a chemical is believed to contribute to global warming over a given time period compared to the same mass of carbon dioxide. Certain materials with high GWPs are called “greenhouse gases.” Some of the major substances recognized as GHGs today include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride. Many ODSs are also GHGs.

HFCs have been widely used as replacements for ODSs. Because they do not contain chlorine or bromine, they have an ODP of 0. However, certain HFCs have high GWPs. PFCs have extremely high GWPs and long atmospheric lifetimes. They do not deplete stratospheric ozone, but the U.S. Environmental Protection Agency (EPA) is concerned about their impact on global warming.

## Halocarbon Potential Contributions to Ozone Depletion and Global Warming

Exhibit 2 provides ODPs for the Class I and Class II ODSs. The ODP values are from Table 1-5 of *The Scientific Assessment of Ozone Depletion, 2002*, a report of the World Meteorological Association’s Global Ozone Research and Monitoring Project. The GWPs of select HFCs, PFCs, and other chemicals of concern for global warming are listed in Exhibit 3. All GWP values in Exhibits 2 and 3 represent global warming potential over a 100-year time horizon and are from Table 1-6 of *The Scientific Assessment of Ozone Depletion, 2002*. The ODSs are sorted by their designations (annexes and groups) under the Montreal Protocol.

For further information regarding ozone depletion, global warming, or other regulatory issues, please contact Sharon Scroggins/MSFC/AS10, Lead of the Principal Center for Clean Air Act Regulations, at (256) 544-7932.

## EXHIBIT 2

## Class I and II ODSs

Chemical Name	CAS Number	Lifetime (years)	ODP	GWP	Chemical Name	CAS Number	Lifetime (years)	ODP	GWP
Class I ODSs									
Annex A					Annex C, ctd.				
Group I					Group II, ctd.				
CFC 11 (CCl <sub>3</sub> F)	75-69-4	45	1.0	4680	C <sub>2</sub> H <sub>2</sub> F <sub>2</sub> Br <sub>2</sub>			0.2-1.5	
CFC 12 (CCl <sub>2</sub> F <sub>2</sub> )	75-71-8	100	1.0	10720	C <sub>2</sub> H <sub>2</sub> F <sub>3</sub> Br			0.7-1.6	
CFC 113 (C <sub>2</sub> F <sub>3</sub> Cl <sub>3</sub> )	76-13-1	85	1.0	6030	C <sub>2</sub> H <sub>3</sub> FBr <sub>2</sub>			0.1-1.7	
CFC 114 (C <sub>2</sub> F <sub>4</sub> Cl <sub>2</sub> )	76-14-2	300	0.94	9880	C <sub>2</sub> H <sub>3</sub> F <sub>2</sub> Br			0.2-1.1	
CFC 115 (C <sub>2</sub> F <sub>5</sub> Cl)	76-15-3	1700	0.44	7250	C <sub>2</sub> H <sub>4</sub> FBr			0.07-0.1	
Group II					C <sub>3</sub> HF <sub>2</sub> Br <sub>5</sub>			0.2-1.9	
Halon 1211 (CF <sub>2</sub> ClBr)	353-59-3	16	6.0	1860	C <sub>3</sub> HF <sub>3</sub> Br <sub>4</sub>			0.3-1.8	
Halon 1301 (CF <sub>3</sub> Br)	75-63-8	65	12	7030	C <sub>3</sub> HF <sub>4</sub> Br <sub>3</sub>			0.5-2.2	
Halon 2402 (C <sub>2</sub> F <sub>4</sub> Br <sub>2</sub> )	124-73-2	20	<8.6	1620	C <sub>3</sub> HF <sub>5</sub> Br <sub>2</sub>			0.9-2.0	
Annex B					C <sub>3</sub> HF <sub>6</sub> Br			0.7-3.3	
Group I					C <sub>3</sub> H <sub>2</sub> FBr <sub>5</sub>			0.1-1.9	
CFC 13 (CF <sub>3</sub> Cl)	75-72-9	640	1.0	14190	C <sub>3</sub> H <sub>2</sub> F <sub>2</sub> Br <sub>4</sub>			0.2-2.1	
CFC 111 (C <sub>2</sub> FCl <sub>3</sub> )	354-56-3		1.0		C <sub>3</sub> H <sub>2</sub> F <sub>3</sub> Br <sub>3</sub>			0.2-5.6	
CFC 112 (C <sub>2</sub> F <sub>2</sub> Cl <sub>4</sub> )	76-12-0		1.0		C <sub>3</sub> H <sub>2</sub> F <sub>4</sub> Br <sub>2</sub>			0.3-7.5	
CFC 211 (C <sub>3</sub> FCl <sub>7</sub> )	422-78-6		1.0		C <sub>3</sub> H <sub>2</sub> F <sub>5</sub> Br			0.9-1.4	
CFC 212 (C <sub>3</sub> F <sub>2</sub> Cl <sub>6</sub> )	3182-26-1		1.0		C <sub>3</sub> H <sub>3</sub> FBr <sub>4</sub>			0.08-1.9	
CFC 213 (C <sub>3</sub> F <sub>3</sub> Cl <sub>5</sub> )	2354-06-5		1.0		C <sub>3</sub> H <sub>3</sub> F <sub>2</sub> Br <sub>3</sub>			0.1-3.1	
CFC 214 (C <sub>3</sub> F <sub>4</sub> Cl <sub>4</sub> )	29255-31-0		1.0		C <sub>3</sub> H <sub>3</sub> F <sub>3</sub> Br <sub>2</sub>			0.1-2.5	
CFC 215 (C <sub>3</sub> F <sub>5</sub> Cl <sub>3</sub> )	4259-43-2		1.0		C <sub>3</sub> H <sub>3</sub> F <sub>4</sub> Br			0.3-4.4	
CFC 216 (C <sub>3</sub> F <sub>6</sub> Cl <sub>2</sub> )	661-97-2		1.0		C <sub>3</sub> H <sub>4</sub> FBr <sub>3</sub>			0.03-0.3	
CFC 217 (C <sub>3</sub> F <sub>7</sub> Cl)	422-86-6		1.0		C <sub>3</sub> H <sub>4</sub> F <sub>2</sub> Br <sub>2</sub>			0.1-1.0	
Group II					C <sub>3</sub> H <sub>4</sub> F <sub>3</sub> Br			0.07-0.8	
Carbon tetrachloride (CCl <sub>4</sub> )	56-23-5	26	0.73	1380	C <sub>3</sub> H <sub>5</sub> FBr <sub>2</sub>			0.04-0.4	
Group III					C <sub>3</sub> H <sub>5</sub> F <sub>2</sub> Br			0.07-0.8	
Methyl Chloroform (C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub> ) (1,1,1-trichloroethane, or TCA)	71-55-6	5.0	0.12	144	C <sub>2</sub> HF <sub>3</sub> Br <sub>2</sub>			0.4-1.6	
Annex C					C <sub>2</sub> HF <sub>4</sub> Br			0.7-1.2	
Group II					C <sub>3</sub> H <sub>6</sub> FBr			0.02-0.7	
CHFBr <sub>2</sub>			1.0		Group III				
HBFC 12B1 (CHF <sub>2</sub> Br)			0.74		Chlorobromomethane (CH <sub>2</sub> BrCl)		0.37	0.12	
CH <sub>2</sub> FBr			0.73		Annex E				
C <sub>2</sub> HFBr <sub>4</sub>			0.3-0.8		Group I				
C <sub>2</sub> H <sub>2</sub> FBr <sub>3</sub>			0.1-1.1		Methyl Bromide (CH <sub>3</sub> Br)	74-83-9	0.7	0.38	5

## EXHIBIT 2

Class I and II ODSs (*cont'd*)

Chemical Name	CAS Number	Lifetime (years)	ODP	GWP	Chemical Name	CAS Number	Lifetime (years)	ODP	GWP
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## Class II ODSs

## Annex C

## Group 1

HCFC 21 (CHFCI <sub>2</sub> )	75-43-4	1.7	0.04	148	HCFC 225cb (C <sub>3</sub> HF <sub>5</sub> CI <sub>2</sub> )	507-55-1	5.8	0.03	586
HCFC 22 (CHF <sub>2</sub> CI)	75-45-6	12.0	0.05	1780	HCFC 226 (C <sub>3</sub> HF <sub>6</sub> CI)	431-87-8		0.02-0.1	
HCFC 31 (CH <sub>2</sub> F <sub>2</sub> CI)	593-70-4		0.02		HCFC 231 (C <sub>3</sub> H <sub>2</sub> F <sub>2</sub> CI <sub>5</sub> )	421-94-3		0.05-0.09	
HCFC 121 (C <sub>2</sub> HFCI <sub>4</sub> )	354-14-3		0.01-0.04		HCFC 232 (C <sub>3</sub> H <sub>2</sub> F <sub>2</sub> CI <sub>4</sub> )	460-89-9		0.008-0.1	
HCFC 122 (C <sub>2</sub> H <sub>2</sub> F <sub>2</sub> CI <sub>3</sub> )	354-21-2		0.02-0.08		HCFC 233 (C <sub>3</sub> H <sub>2</sub> F <sub>3</sub> CI <sub>3</sub> )	7125-84-0		0.007-0.23	
HCFC 123 (C <sub>2</sub> H <sub>2</sub> F <sub>3</sub> CI <sub>2</sub> )	306-83-2	1.3	0.02	76	HCFC 234 (C <sub>3</sub> H <sub>2</sub> F <sub>4</sub> CI <sub>2</sub> )	425-94-5		0.01-0.28	
HCFC 124 (C <sub>2</sub> H <sub>2</sub> F <sub>4</sub> CI)	2837-89-0	5.8	0.02	599	HCFC 235 (C <sub>3</sub> H <sub>2</sub> F <sub>5</sub> CI)	460-92-4		0.03-0.52	
HCFC 131 (C <sub>2</sub> H <sub>2</sub> F <sub>3</sub> CI <sub>3</sub> )	359-28-4		0.007-0.05		HCFC 241 (C <sub>3</sub> H <sub>3</sub> F <sub>3</sub> CI <sub>4</sub> )	666-27-3		0.004-0.09	
HCFC 132b (C <sub>2</sub> H <sub>2</sub> F <sub>2</sub> CI <sub>2</sub> )	1649-08-7		0.008-0.05		HCFC 242 (C <sub>3</sub> H <sub>3</sub> F <sub>2</sub> CI <sub>3</sub> )	460-63-9		0.005-0.13	
HCFC 133a (C <sub>2</sub> H <sub>2</sub> F <sub>3</sub> CI)	75-88-7		0.02-0.06		HCFC 243 (C <sub>3</sub> H <sub>3</sub> F <sub>3</sub> CI <sub>2</sub> )	460-69-5		0.007-0.12	
HCFC 141b (C <sub>2</sub> H <sub>3</sub> F <sub>2</sub> CI <sub>2</sub> )	1717-00-6	9.3	0.12	713	HCFC 244 (C <sub>3</sub> H <sub>3</sub> F <sub>4</sub> CI)			0.009-0.14	
HCFC 142b (C <sub>2</sub> H <sub>3</sub> F <sub>2</sub> CI)	75-68-3	17.9	0.07	2270	HCFC 251 (C <sub>3</sub> H <sub>4</sub> F <sub>3</sub> CI <sub>3</sub> )	421-41-0		0.001-0.01	
HCFC 221 (C <sub>3</sub> HFCI <sub>6</sub> )	422-26-4		0.015-0.07		HCFC 252 (C <sub>3</sub> H <sub>4</sub> F <sub>2</sub> CI <sub>2</sub> )	819-00-1		0.005-0.04	
HCFC 222 (C <sub>3</sub> HF <sub>2</sub> CI <sub>5</sub> )	422-49-1		0.01-0.09		HCFC 253 (C <sub>3</sub> H <sub>4</sub> F <sub>3</sub> CI)	460-35-5		0.003-0.03	
HCFC 223 (C <sub>3</sub> HF <sub>3</sub> CI <sub>4</sub> )	422-52-6		0.01-0.08		HCFC 261 (C <sub>3</sub> H <sub>5</sub> F <sub>3</sub> CI <sub>2</sub> )	420-97-3		0.002-0.02	
HCFC 224 (C <sub>3</sub> HF <sub>4</sub> CI <sub>3</sub> )	422-54-8		0.01-0.09		HCFC 262 (C <sub>3</sub> H <sub>5</sub> F <sub>2</sub> CI)	421-02-03		0.002-0.02	
HCFC 225ca (C <sub>3</sub> HF <sub>5</sub> CI <sub>2</sub> )	422-56-0	1.9	0.02	120	HCFC 271 (C <sub>3</sub> H <sub>6</sub> F <sub>3</sub> CI)	430-55-7		0.001-0.03	

## Annex D

Annex D is a list of products that contain controlled substances specified in Annex A.

Automobile and truck air conditioning units  
Aerosol products, except medical aerosols  
Portable fire extinguishers  
Insulation boards, panels and pipe covers  
Pre-polymers

Domestic and commercial refrigeration  
and air conditioning/heat pump equipment including:

- Refrigerators,
- Freezers,
- Dehumidifiers,
- Water coolers,
- Ice machines,
- Air conditioning and
- Heat pump units

**EXHIBIT 3****HFCs, PFCs, and Other Chemicals of Concern**

Chemical	Atmospheric Lifetime	GWP	Use
<b>HFCs</b>			
HFC 23 (CHF <sub>3</sub> )	270	12240	Byproduct of HCFC 22; used in very-low temperature refrigeration blend, fire suppression, plasma etching, and cleaning in semiconductor production.
HFC 32 (CH <sub>2</sub> F <sub>2</sub> )	4.9	543	Blend component of numerous refrigerants.
HFC 41 (CH <sub>3</sub> F)	2.4	90	Not in use today.
HFC 43-10mee (C <sub>3</sub> H <sub>2</sub> F <sub>10</sub> )	15.9	1610	Cleaning solvent.
HFC 125 (C <sub>2</sub> HF <sub>5</sub> )	29	3450	Blend component of numerous refrigerants and a fire suppressant.
HFC 134 (C <sub>2</sub> H <sub>2</sub> F <sub>4</sub> )	9.6	1090	Not in use today.
HFC 134a (CH <sub>2</sub> FCF <sub>3</sub> )	14	1320	Widely used refrigerant blend, foam blowing agent, fire suppressant, and propellant in metered-dose inhalers and aerosols.
HFC 143 (C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> )	3.5	347	Not in use today.
HFC 143a (C <sub>2</sub> H <sub>3</sub> F <sub>3</sub> )	52	4400	Blend component of several refrigerant blends.
HFC 152a (C <sub>2</sub> H <sub>4</sub> F <sub>2</sub> )	1.4	122	Blend component of several refrigerant blends and foam blowing agent. Also used as an aerosol propellant.
HFC 227ea (C <sub>3</sub> HF <sub>7</sub> )	34.2	3660	Fire suppressant and propellant for metered-dose inhalers, and refrigerant.
HFC 236fa (C <sub>3</sub> H <sub>2</sub> F <sub>6</sub> )	240	9650	Refrigerant and fire suppressant.
HFC 236ea (C <sub>3</sub> H <sub>2</sub> F <sub>6</sub> )	10.7	1350	Not in use today.
HFC 245ca (C <sub>3</sub> H <sub>3</sub> F <sub>5</sub> )	6.2	682	Not in use today; possible refrigerant in the future.
HFC 245fa (C <sub>3</sub> H <sub>3</sub> F <sub>5</sub> )	7.6	1020	Foam blowing agent and possible refrigerant in the future.
HFC 365mfc (C <sub>4</sub> H <sub>5</sub> F <sub>5</sub> )	8.6	782	Some use as a foam blowing agent; possible refrigerant in the future.
<b>PFCs</b>			
Perfluoromethane (CF <sub>4</sub> )	50000	5820	Plasma etching and cleaning in semiconductor production, low temperature refrigerant.
Perfluoroethane (C <sub>2</sub> F <sub>6</sub> )	10000	12010	Plasma etching and cleaning in semiconductor production.
Perfluoropropane (C <sub>3</sub> F <sub>8</sub> )	2600	8690	Plasma etching and cleaning in semiconductor production, low temperature refrigerant and fire suppressant.
Perfluorobutane (C <sub>4</sub> F <sub>10</sub> )	2600	8710	Fire suppressant and refrigerant when alternatives are not technically feasible.
Perfluorocyclobutane (c-C <sub>4</sub> F <sub>8</sub> )	3200	10090	Not used much. Refrigerant when alternatives are not technically feasible.
Perfluoropentane (C <sub>5</sub> F <sub>12</sub> )	4100	9010	Not used much. Precision cleaning solvent-low use refrigerant when alternatives are not technically feasible.
Perfluorohexane (C <sub>6</sub> F <sub>14</sub> )	3200	9140	Precision cleaning solvent-low use, refrigerant and fire suppressant when alternatives are not technically feasible.
<b>Others</b>			
NF <sub>3</sub>	740	10970	Plasma etching and cleaning in semiconductor production.
Sulfur hexafluoride (SF <sub>6</sub> )	3200	22450	Casting dielectric gas and insulator in electric power equipment fire suppression, discharge agent in military systems, formerly aerosol propellant.
HFE-7100 (C <sub>4</sub> F <sub>9</sub> OCH <sub>3</sub> )	5.0	397	Cleaning solvent and heat transfer fluid.
HFE-7200 (C <sub>4</sub> F <sub>9</sub> OC <sub>2</sub> H <sub>5</sub> )	0.77	56	Cleaning solvent and heat transfer fluid